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Shark Diversity and Relative Abundance at Myrtle Beach, SC Fishing Piers

By

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Marine Science

Submitted in Partial Fulfillment of the
Requirements for the Degree of Bachelor of Science
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INTRODUCTION:

Sharks are frequently observed at fishing piers (Barwick *et al.* 2004; Martin *et al.* 2019). These piers offer structural habitats for shark prey items, such as smaller fish and invertebrates, which can attract sharks to piers (Barwick *et al.* 2004; Heupel 2005). Additionally, fishers often clean their catch and discard entrails at the pier, which also may attract sharks (Martin *et al.* 2019). Moreover, other factors could play a role in attracting sharks to piers. These include water quality parameters, like salinity and temperature, and the physical characteristics of the pier (Ulrich *et al.* 2007; Castro 1996; Heupel 2005).

Each pier is unique, in terms of physical characteristics (e.g., length, building materials, height, age, etc.), bottom types, and depth profiles around the piers, all of which could influence community dynamics around the pier (Barwick *et al.* 2004; Azevedo *et al.* 2006; Munari 2013; Rowe and Dean 1998). Fisher density, while not a direct driver of shark abundance, could also be influential. The bait used by fisherman and entrails from cleaning their catch could influence the feeding strategies of sharks around piers (Martin *et al.* 2019).

Approximately thirty species of sharks that have been observed along the South Carolina coast. Two of the most common species are *Carcharhinus plumbeus*, the Sandbar Shark (Figure 1), and *Carcharhinus limbatus*, the Blacktip Shark (Figure 2). Sandbar Sharks are typically grey or brown in color, averaging 3 to 6 feet in length. They have stout, compact bodies, blunt noses, and broad heads. There are two main distinguishing characteristics on Sandbar Sharks, the first being an interdorsal ridge. This is a small elevation running from the first dorsal fin to the second dorsal fin, a characteristic of ridgeback sharks. The second and most distinguishing characteristic of Sandbar Sharks is their first dorsal fin. This fin is exceptionally large and is one of the largest first dorsal fins relative to body size among any shark (Farmer 2004; Abel and Grubbs 2020). Sandbar Sharks are typically observed in South Carolina waters from April to late November (Ulrich *et al.* 2007).

Blacktip Sharks are dark or light grey in color, averaging 3 to 5 feet in length. These sharks are sleeker than Sandbar Sharks, lack an interdorsal ridge, and have a tapering snout. Like many

other shark species, the fins of Blacktip Sharks are tipped black. Ironically, however, the anal fin of Blacktip Sharks is the only fin to not have a blacktip. Instead, the anal fin has a less prominent, grey smudge, which is a distinguishing characteristic of this species. The first dorsal fin of the Blacktip Shark is much smaller than that of the Sandbar Shark and is largely triangular with a backward curving tip (Farmer 2004; Abel and Grubbs 2020). Blacktip Sharks have been observed in South Carolina waters from May to early November (Ulrich *et al.* 2007).

Martin *et al.* (2019) explored the relationship between sharks and piers in the Myrtle Beach area. In 2016 and 2017, 12 Blacktip Sharks were tagged and monitored via acoustic telemetry at six different fishing piers: Apache Pier, Pier 14, 2nd Avenue Pier, Springmaid Pier, Myrtle Beach State Park Pier, and Garden City Pier. Martin *et al.* (2019) observed an infrequent association of tagged sharks with piers. Three individuals were observed frequenting the same pier at which they were initially tagged, and one individual was detected only at MBSP pier throughout the two-year study. They found that adult Blacktip Sharks experienced seasonal associations with the piers. Receiver data showed Blacktip Sharks migrating south from South Carolina in early November, likely in response to various changing environmental cues. Martin *et al.* (2019) also observed sharks visiting Pier 14, 2nd Avenue Pier, and Myrtle Beach State Park Pier more frequently than the other three piers sampled. At each pier they observed sharks feeding on discarded scraps and circling cleaning stations at the piers. This suggests that Blacktip Sharks are likely utilizing piers as feeding habitats.

This study was employed as a supplement to the research conducted by Martin *et al.* (2019) to describe the relationship between sharks and piers more comprehensively, rather than focusing on a single shark species. Our study aims to identify shark species present around Myrtle Beach fishing piers, estimate relative shark abundances at these piers, and identify different factors that may influence the presence or absence of sharks around piers.

METHODS:

Thirty-one observations were made from September 2020 to November 2020 at the following piers[1]: Apache Pier, 2nd Avenue Pier, Springmaid Pier, Myrtle Beach State Park Pier, and Garden City Pier (Figure 3). This research did not begin earlier in the South Carolina shark season due to COVID-19 restrictions, which prevented us from traveling to the area to begin sampling our period. Observations were taken for two hours on each observational day beginning at times of predicted high tide or low tide based on NOAA's tides and currents tables. Piers were visited with equal effort during each tidal stage. Piers were not visited the same number of times for various reasons. Sea surface temperature and salinity data were obtained from SUTRONWin, a comprehensive water quality data set that can be accessed online. Only data from 2nd Ave Pier and Apache Pier were available on this platform. To account for unavailable data, the parameters for 2nd Ave Pier were used for Springmaid Pier (2.9 mi away), Myrtle Beach State Park Pier (6.2 mi away), and Garden City Pier (11 mi away). Given that piers are generally in the well-mixed surf zone, we assumed that surface and bottom conditions were the same, recording only SUTRONWin's data for surface conditions. Lastly, each shark observed was identified to species, where possible, using the distinguishing characteristics listed above. All observed sharks were not necessarily unique individuals since tagging was not employed.

Analysis

Relative shark abundances were calculated both by species and pier. Abundances and influences of temperature, salinity, and tide were analyzed using a single-factor ANOVA test ($p < 0.05$). If the ANOVA yielded significant differences between the groups, a Games-Howell post-hoc test was used. It is important to note that the data collected for Springmaid Pier were excluded in the analysis on temperature, salinity, and tide to decrease outliers in the analysis due to absence of visible sharks at this pier, for reasons we discuss below.

RESULTS:

Ninety-four shark individuals in two species (Sandbar Sharks, *Carcharhinus plumbeus*, N = 53; and Blacktip Sharks, *Carcharhinus limbatus,* N = 39) were identified during this study (Figure 4). Two Carcharhinid shark individuals could not be identified to species.

[1] While Martin *et al.* (2019) visited Pier 14, we did not. This is a very popular pier, and due to COVID-19, we did not feel comfortable sampling at this pier in such large crowds.

Garden City Pier

Garden City Pier was visited on 11 days throughout the sampling period. Sharks were seen every day at this pier, with a total of 78 sharks observed (Table 1). On each day, 1 to 15 (μ = 7.1) sharks were observed.

2nd Avenue Pier

2nd Ave Pier was visited on 7 days throughout the sampling period. Sharks were seen on 4 of these 11 days, with a total of 11 sharks observed (Table 1). On each day that sharks were present, 0 to 4 (μ = 1.6) sharks were observed.

Apache Pier

Apache Pier was visited on 2 days throughout the sampling period. Sharks were seen on 1 of these days, with a total of 3 sharks observed (Table 1). On the day that sharks were present, 0 to 3 (μ = 1.5) sharks were observed.

Myrtle Beach State Park Pier

MBSP Pier was visited on 7 days throughout the sampling period. Sharks were seen on 1 of these 7 days, with a total of 2 sharks observed (Table 1). On the day that sharks were present, 0 to 2 (μ = 0.3) sharks were observed.

Springmaid Pier

Springmaid Pier was visited on 4 days throughout the sampling period; however, sharks were observed on none of these days (Table 1). There was a significant difference among the number of sharks observed at each pier ($F(2, 26) = 9.21$, $p < 0.05$). A Games-Howell post-hoc revealed that more sharks were significantly seen at Garden City Pier than at Myrtle Beach State Park Pier, 2nd Avenue Pier, and Apache Pier.

Temperature

Sharks were found in temperatures ranging from 21.5 °C - 30.3 °C (μ = 25.07 °C; Figure 5). Blacktip Sharks were found in a temperature range of 24.2 °C - 30.2 °C (μ = 25.3 °C). Sandbar Sharks were found in a temperature range of 23.2 °C - 25.5 °C (μ = 24.6 °C). The unidentified

shark species were found in a temperature range of 24.9 °C - 29.3 °C (μ = 27.1 °C; Figure 6). There was a significant difference among the number of sharks observed at different temperature ranges ($F(11, 53) = 539$, $p < 0.05$). A Games-Howell post-hoc revealed that more sharks were significantly seen within temperatures ranging from 24 °C – 26 °C.

Salinity

Sharks were found in salinities ranging from 33.06 PSU - 35.23 PSU (μ = 33.9 PSU; Figure 7). Blacktip Sharks were found in a salinity range of 33.2 PSU - 35.23 PSU (μ = 34.13 PSU). Sandbar Sharks were found in a salinity range of 33.23 PSU - 34.11 PSU (μ = 33.59 PSU). The unidentified shark species were found in a salinity range of 33.34 PSU - 35.12 PSU (μ = 34.23 PSU; Figure 8). There was a significant difference among the number of sharks observed at different salinity ranges ($F(5, 53) = 1409$, $p < 0.05$). A Games-Howell post-hoc revealed that more sharks were significantly seen within salinities ranging from 33 PSU – 34 PSU.

Tide:

Of the 94 sharks observed in this study, 31 sharks were observed during high tide and 63 sharks were observed during low tide. There was no significant difference among the number of sharks observed at different tidal stages ($F(2, 26) = 1.78$, $p > 0.05$).

DISCUSSION:

Relative Abundance

More Sandbar Sharks were observed in this study than Blacktip Sharks (Figure 4), with most sharks observed at Garden City Pier (Table 1). The timing of the sampling period may have impacted this observation. Since this sample largely took place in the Fall, water temperatures were intermittently falling. Sandbar Sharks are a temperate species, therefore are able to occupy cooler temperature extremes than that of Blacktip Sharks, a temperate-tropical species (Abel and Grubbs 2020; Castro 1996). Meaning, that as water temperatures began to fall, some Blacktip Sharks may have already begun their migrations to the south where warmer bodies of water reside, leaving more Sandbar Sharks to be observed (Castro 1996). Furthermore, Garden City Pier was the southernmost pier sampled within this study (Figure 3). The water temperatures

surrounding this pier may have been warmer during the late sampling period than more northern piers along the coast, resulting in a higher abundance of sharks around Garden City Pier. Martin *et al.* (2019) found more sharks utilizing other piers, specifically Pier 14, 2nd Ave Pier, and MBSP Pier. The variation in our data are likely due to Martin *et al.* (2019) utilizing a larger sampling period than ours.

Surprisingly, no sharks were observed at Springmaid Pier (Table 1). In 2016, this pier was destroyed by Hurricane Matthew and just recently reopened on July 3, 2020 (Thomas 2020). Reconstruction of this pier was a disruptive event that may have deterred shark prey and sharks in general (Abel and Grubbs 2020; de Vincenzi *et al.* 2021; Erbe 2009). During early stages of construction, the sea-floor likely experienced pile driving, which emits loud sounds and causes increased turbidity. Loud, anthropogenic noises often deter fish communities from the area, and can cause mass death events if the organisms remain in the area (Erbe 2009). Thus, during the early stages of pile driving, it is likely that noise from construction deterred sharks and their prey (Abel and Grubbs 2020; de Vincenzi *et al.* 2021; Erbe 2009). Furthermore, pile driving increases the turbidity in the water, which can decrease foraging opportunities for different species (Rowe and Dean 1998). In response, it is likely that fish species migrated away from this pier to environments with less turbidity to increase their foraging success (Rowe and Dean 1998). In combination with the noise and turbidity effects, it is possible that the new pier itself may not have been mature enough to support benthic organisms (Munari 2013). Benthic organisms that attach to structures need time to adhere, meaning Springmaid Pier may have been too immature to allow time for benthic communities to form (Munari 2013; Azevedo *et al.* 2006). If these communities were not yet formed on Springmaid Pier, fish and shark species were likely utilizing other piers as habitats since some of their prey were not present at the pier. The combination of these effects, noise disturbances, decreased turbidity, and immaturity of the structure, are likely influencing the absence of sharks around Springmaid Pier.

Similar to Martin *et al.* (2019), we also found that most sharks appeared when dead fish were thrown into the water. Henrich *et al.* (2021) looked at how touristic feeding of sharks creates anticipatory behavior in the sharks. They fed Lemon Sharks, *Negaprion brevirostris*, in Aya's Spot, Bahamas over a continuous twenty-seven days for one hour before low tide. After

the twenty-seven days, they stopped feeding the sharks and found that the tagged Lemon Sharks remained near Aya's spot during that one-hour period for ninety days after they stopped feeding. They found that anticipatory behavior of these sharks can occur within eleven days of the initial daily feeding events (Heinrich *et al.* 2021). Sharks observed around piers could similarly return to these piers due to touristic feeding events, like fisherman throwing bait and entrails into the water. This is consistent with what Martin *et al.* (2019) found, where 9 of the 12 tagged Blacktip Sharks displayed varying degrees of pier association. Since we did not employ tagging data within this study, we cannot clearly determine that all individuals observed at piers were returning to the same or other piers. However, we were able to identify one individual frequenting Garden City Pier. A Sandbar Shark with a slight wound on its first dorsal fin was identified at Garden City Pier on two separate dates, October 10th and October 23rd, only 13 day apart. Observing this individual at Garden City Pier, coupled with Martin *et al.*'s (2019) data showing four tagged individuals frequenting the same pier, could indicate that sharks are utilizing the same piers over a period of time.

Temperature

The highest water temperatures were recorded in September when Blacktip Sharks were most abundant (Figure 6). Blacktip Sharks were likely more abundant during this time as they have a higher water temperature tolerance than do Sandbar Sharks (Castro 1996; Ulrich *et al.* 2007). Consistent with Martin *et al*. (2019), the coldest water temperatures were observed in mid-November when shark presence was relatively low (Figure 5). However, some Sandbar Sharks were observed during this time frame (Figure 6). Sandbar Sharks are a temperate species, thus are more adapted to living in lower water temperatures (Abel and Grubbs 2020; Ulrich *et al.* 2007). Local sharks must perform seasonal migrations throughout the year to reduce the energy cost of maintaining homeostasis since most species are ectotherms (Abel and Grubbs 2020; Castro 1996). Meaning, when the water temperature becomes too cold, sharks will migrate south where water will be more equivalent to their water temperature thresholds. The presence of both Blacktip and Sandbar Sharks are typical of the months when they are present in South Carolina waters. Blacktip Sharks are commonly found in South Carolina from May to early November, months that display a warmer water temperature range (Ulrich *et al.* 2007). Sandbar Sharks, however, are observed in South Carolina from April to mid-November, months that display a

wider range of water temperatures (Ulrich *et al.* 2007). Meaning, Sandbar Sharks are traditionally seen in a wider temperature range than Blacktip Sharks since they are more tolerant of cooler water temperatures (Abel and Grubbs 2020). In this study, however, we observed Blacktip Sharks in a wider temperature range than Sandbar Sharks (Figure 6). This study began in September, when water temperature is relatively warmer. This could possibly explain why Blacktip Sharks were found in a wider temperature range. If this study were conducted on a longer time scale and was begun when sharks are first present in South Carolina waters, we may have found Sandbar Sharks in a wider temperature range than Blacktip Sharks.

Salinity

The highest salinities were recorded in September when most Blacktip Sharks were observed (Figure 8). The lowest salinities were recorded in mid-November when a mix of Blacktip and Sandbar Sharks were observed (Figure 8). While the ANOVA and Games-Howell post hoc tests showed significant differences within this data, we believe that there actually is no significance within this data. Salinities in this study had a limited range, between approximately 33 PSU and 36 PSU. Shoreline salinity has typical fluctuations with changing weather conditions. If precipitation increases over a period of time, salinity will decrease due to dilution. If precipitation decreases over a period of time, the salinity will increase due to increased evaporation. It is likely that sharks living along the coast are accustom to slight salinity variations in response to changing weather (Abel *et al.* 2007). Thus, the abundance of sharks observed around piers is likely unphased by minute changes in salinity. It is more likely that a combination of temperature and salinity changes are affecting shark presence around piers (Ulrich *et al.* 2007). In this study, we observed more Blacktip Sharks within higher salinity tolerances than Sandbar Sharks, which is characteristic of Blacktips (Ulrich *et al*. 2007). In South Carolina, Blacktip Sharks can be observed in mean salinities of 31.78 PSU whereas Sandbar Sharks can be observed in mean salinities of 28.43 PSU (Ulrich *et al*. 2007). Thus, the results in this study are consistent with the trends of salinity tolerances of these Blacktip and Sandbar Sharks.

Tide

More sharks were observed during low tide than high tide after visiting piers during each stage with equal effort. However, the ANOVA results showed no significant difference in these observations. The lack of water clarity in the Myrtle Beach area could be influencing this tidal data. Since water depth is greater during high tide, it could have been hard to see sharks that may be dispersing into deeper waters. Thus, observing sharks during low tide may have been easier since depth is shallower during this tidal stage, reducing the depth at which sharks can disperse. To improve this data, tags should be employed to accurately quantify shark presence around piers during tidal stages when depths are greater.

CONCLUSIONS:

1. Blacktip Sharks and Sandbar Sharks were the dominant species observed at the five sampled fishing piers.
2. Characteristics specific to each pier may impact shark presence. The factors that likely determine their presence include different bottom types and depth profiles around the piers, the maturity of the pier itself, and different fishing pressures at the piers. This is notably seen in our data from Springmaid Pier.
3. Sharks may be utilizing piers as feeding habitats since their presence is most abundant when fisherman are throwing in bait or entrails from cleaning their catch. Sharks may have developed associative behaviors with this touristic feeding strategy, similar to what was found in Heinrich *et al.* (2021).
4. Temperature is likely an important factor influencing shark presence around piers and possibly the entire shoreline. Local sharks must seasonally migrate with changing water temperatures in order to maintain homeostasis since most species are ectotherms. Meaning, as water temperature changes, so does the abundance of shark species along the shoreline.
5. In this study, Blacktip Sharks are seen with higher temperature tolerances and within wider temperature ranges than Sandbar Sharks. Blacktip Sharks are tolerant of higher temperatures than Sandbar Sharks, however, a longer sampling period may have shown Sandbar Sharks in a wider temperature range which is characteristic of that species.

6. To better determine environmental influences and a more comprehensive understanding of shark species around piers, a longer sampling period should be employed to collect a larger data set for comparison.

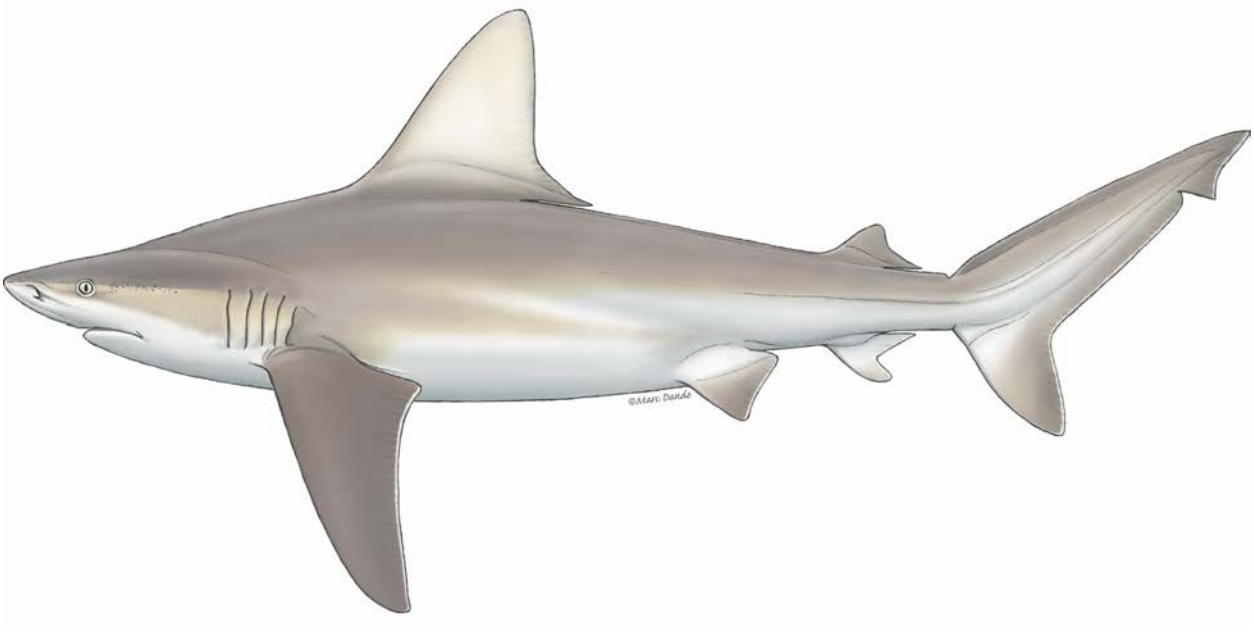

Figure 1: Sandbar Shark (*Carcharhinus plumbeus*) from *Shark Biology and Conservation* by Abel and Grubbs (2020).

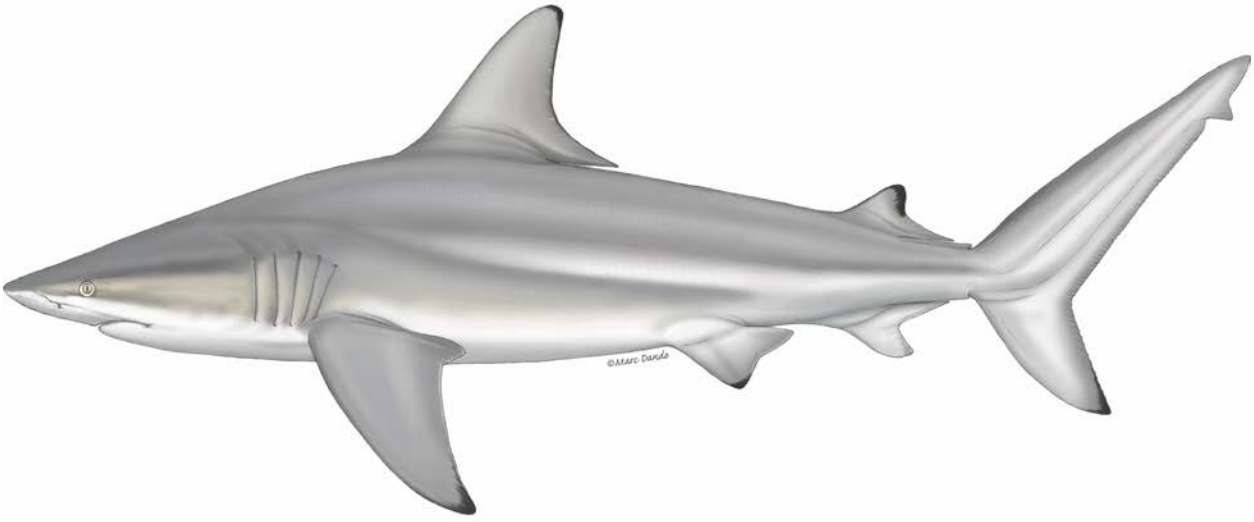

Figure 2: Blacktip Shark (*Carcharhinus limbatus*) from *Shark Biology and Conservation* by Abel and Grubbs (2020).

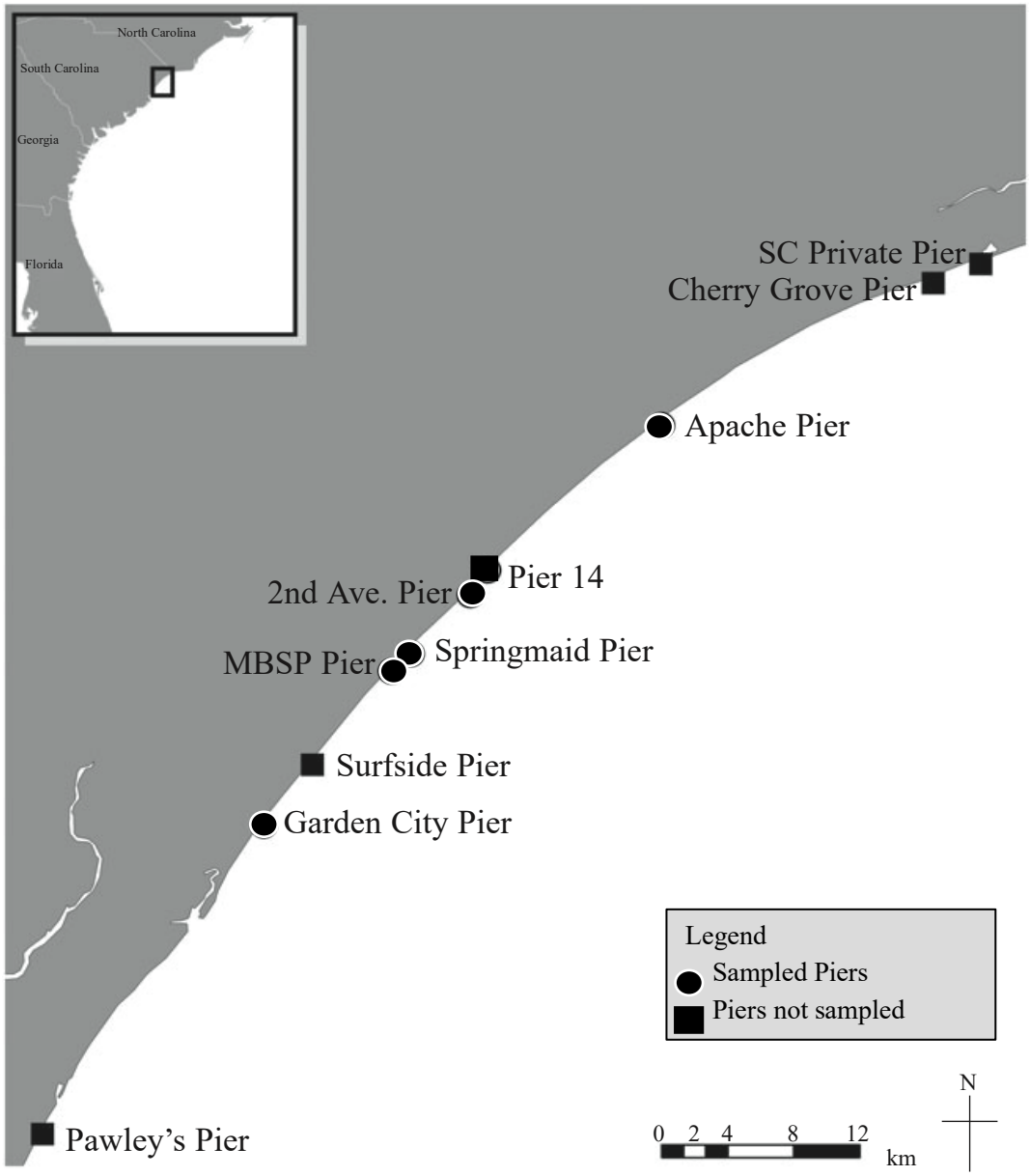

Figure 3: Commercial and fishing piers in the Grand Strand, South Carolina. Modified from Martin *et al.* (2019).

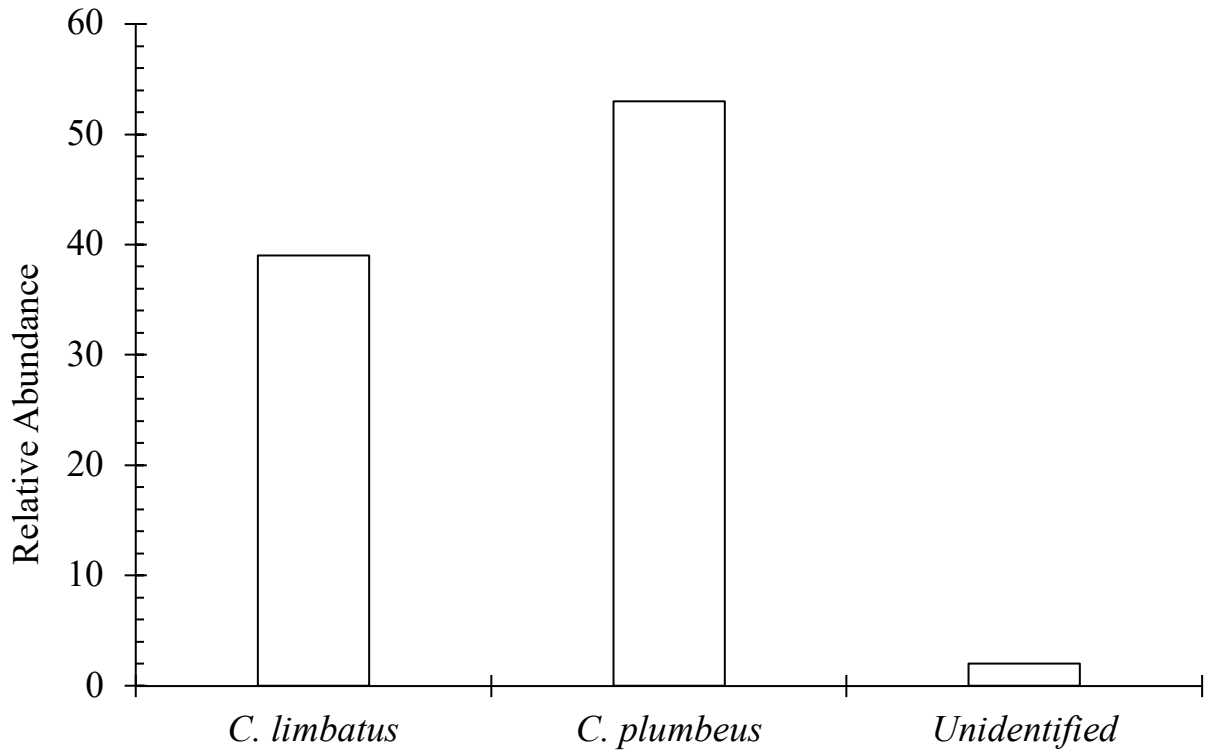

Figure 4: Relative abundance of shark species observed at five Myrtle Beach Piers from September to November 2020.

Table 1: Summary of shark data collected from five Myrtle Beach piers from September to November 2020.

Pier	Total # Days Observed	# Days Sharks Seen	Total # Sharks Observed	Range	Mean	Mode
Garden City Pier	11	11	78	1-15	7.1	5
2nd Ave Pier	7	4	11	0-4	1.6	2
Apache Pier	2	1	3	0-3	1.5	N/A
MBSP Pier	7	1	2	0-2	0.3	2
Springmaid Pier	4	0	0	N/A	N/A	N/A

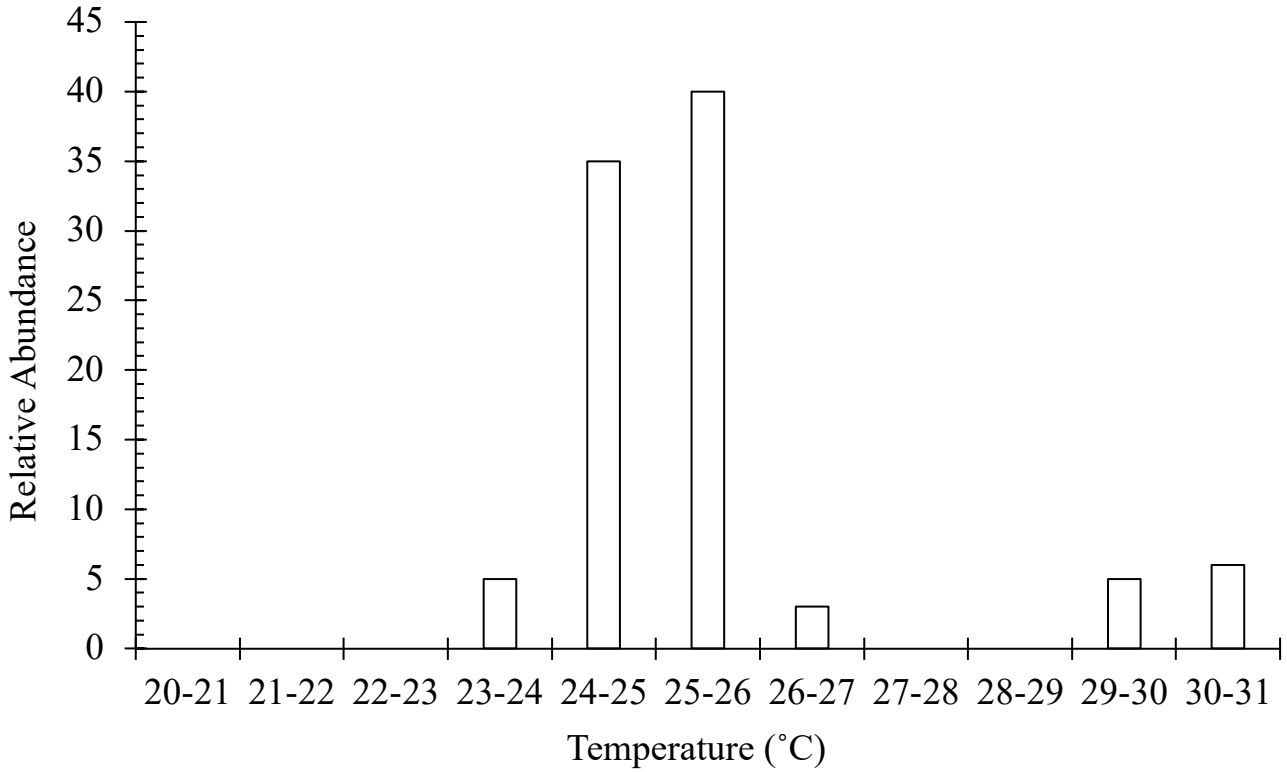

Figure 5: Relative shark abundances over obtained water temperature ranges from five Myrtle Beach piers from September to November 2020.

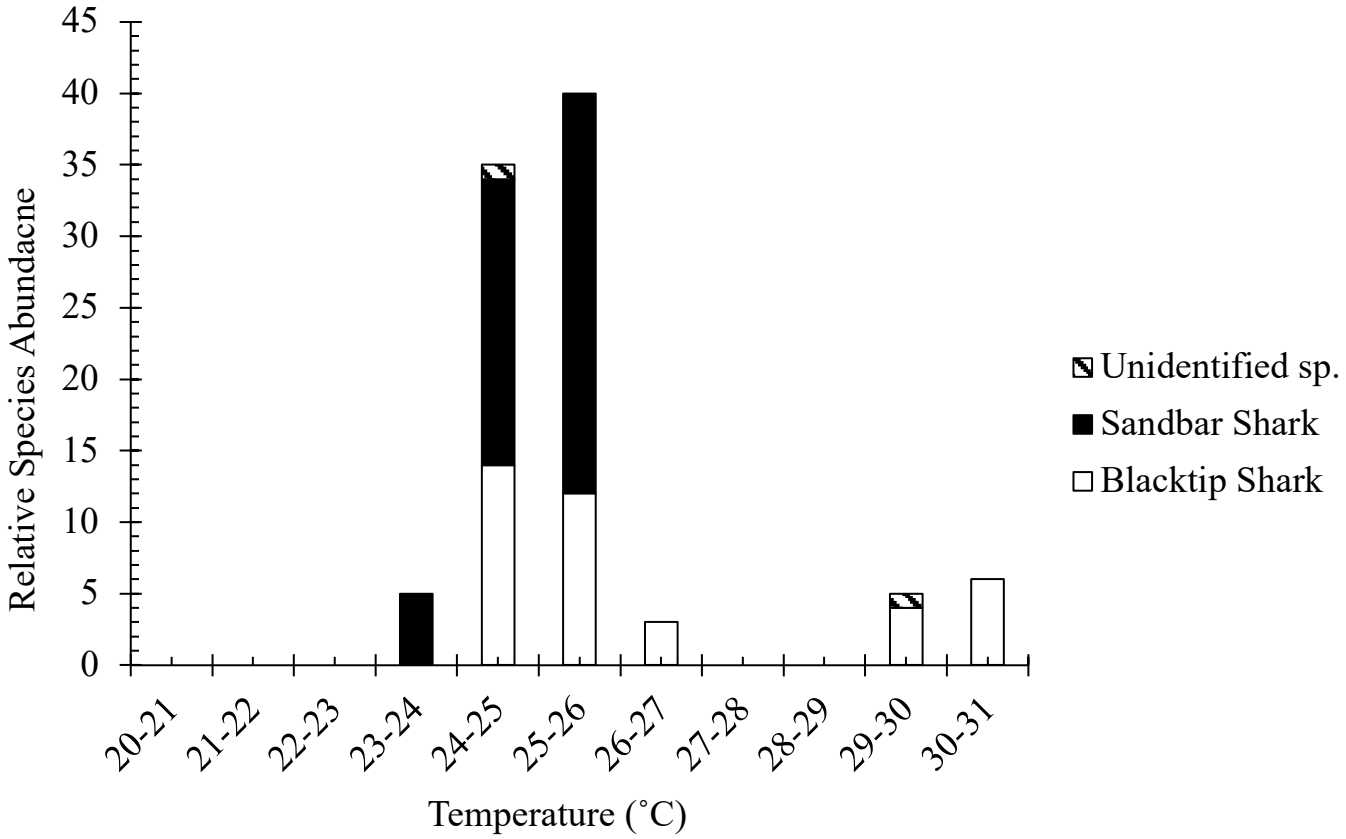

Figure 6: Relative shark species abundances over obtained water temperature ranges from five Myrtle Beach piers from September to November 2020.

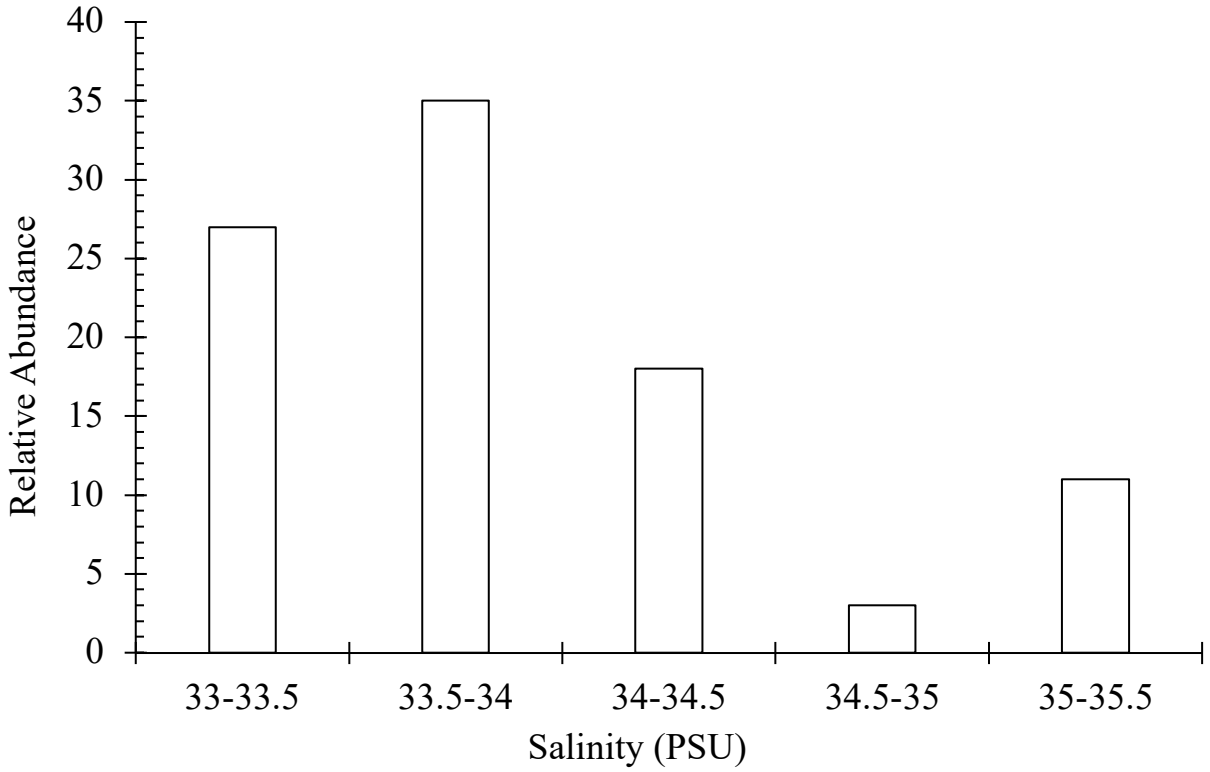

Figure 7: Relative shark abundances over obtained salinity ranges from five Myrtle Beach piers from September to November 2020.

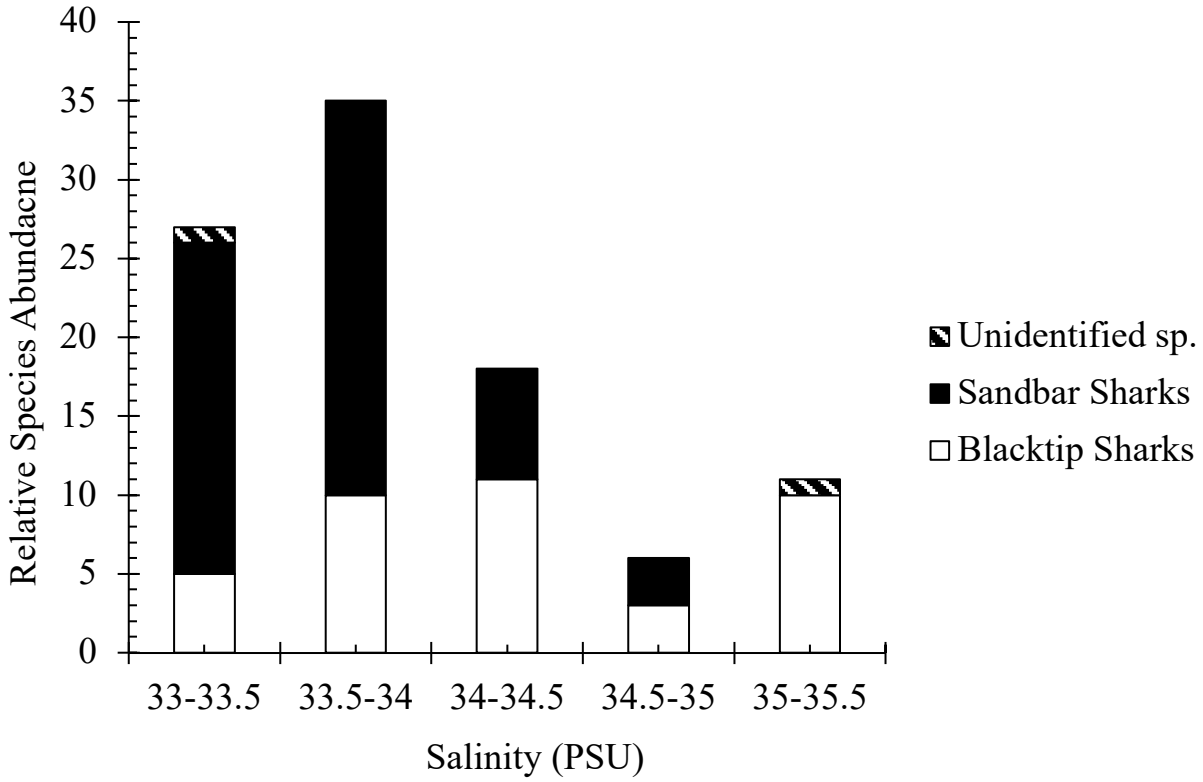

Figure 8: Relative shark species abundances over obtained salinity ranges from five Myrtle Beach piers from September to November 2020.

Photos taken by Lynsey Isner over the course of this study.

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